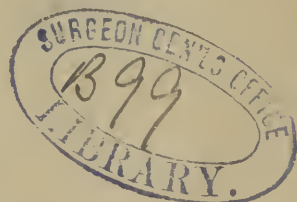


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BY J. H. WYT^{HE}, M. D.,

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An address delivered at the Anniversary Meeting of the San Francisco
Medical Society, November, 1879.

In addressing this medical association, so largely representative of the scientific learning and culture of the most cosmopolitan city in the world, I am not vain enough to imagine that I can present any new theme, nor that I can better elaborate an old one than many of those who listen to me. I deem it an honor and a token of your confidence, to have been appointed your orator at this annual meeting, and can trust to your generosity to overlook whatever may seem immature or imperfect in my remarks.

In selecting a topic of general interest to the profession, rather than one which would tempt me to indulge in vague generalizations or eulogies respecting medical progress, I am following a custom of some of the leading scientific associations of Europe and America, and not unusual here—a custom both useful and appropriate.

The theme I propose is that of Disease-Germs, a subject so influential in etiology as to have quickened many fertile imaginations, from the days of Varro and Columella to the present, although it has also led to valuable practical results. If, in the

light furnished by the recent advances of biology, I can dis sever the romantic and imaginative from the true, so as to indicate the real importance of disease-germs among the *materies morbi*, I shall have accomplished much.

Every agency of nature outside of the bodily organism, and every activity of body and of mind within the living structure, is capable of becoming a cause of disease, as soon as it disturbs the normal current of life, so that the number of causes is practically unlimited. Of all the causes of disease, the most difficult to isolate and investigate are those which produce what are known as miasmatic and contagious, or infectious, diseases—diseases which may be diffused through the air or water, and those which spread from one person to another.

Formerly infectious diseases were regarded as products of gaseous chemical action—so-called fermentation—or zymotic diseases; but more recently they have been considered to be each the result of a virus, in all probability specific; or a special poisonous substance has been imagined for each disease. The discoveries of the last few years have tended still further to isolate the causes of this class of diseases, and the theory of *contagium vivum* has found very general acceptance. In other words, the belief is now very general that the causes of contagious affections, and perhaps also of miasmatic diseases, are living, or organic, causes, so that these derangements are not merely the physical or chemical result of the action of inorganic matter. From this view it is but a step to the germ theory of disease.

Under the general title of disease germ, two distinct theories claim consideration: 1. The theory of vegetable parasites in the blood, generally fungi, and of this class most commonly the various species of *Bacteria*. This has been very elaborately worked out by the German pathologists, and has been favorably regarded in other countries since the publication of the observations of Pasteur, Salisbury and others. 2. The germ theory of Dr. Lionel S. Beale, who considers that “the particles concerned in the propagation of contagious diseases are allied in constitution to the living matter, or bioplasm, of the organism,” and “derived by uninterrupted descent from the bioplasm, or living matter, of an organism, which at an antecedent period may have been perfectly healthy.”

The definition of a germ given by Dr. Beale is identical with

what modern biology terms a cell, or the elementary unit of living beings. It is simply a piece of bioplasm, "a particle of living matter, which has been detached from already existing living matter." "The living particle which sprouts from a cell of the adult plant or organism, and is then detached, may be called a germ, as well as the living particle formed in the ovum, or the living matter in the ovary, from which the new being is evolved." It is evident that this meaning to which the term, "germ" is restricted is a special meaning, and, so far as it implies reproduction, is limited to the multiplication of similar cells, and not of individuals, as in the case of the ovum. The various masses of bioplasm into which the ovum of man or of the higher animals subdivides, are exact counterparts of each other, so far as external appearance and chemical composition are concerned, but they differ greatly in power. Some produce glands, some, muscle; others, nerve, bone, vessels, etc. The powers of these bioplasts, once lost, can never be regained, although they may continue to live and be nourished, and multiply even more actively than before. Indeed, observation shows that degradation in power is generally associated with increased rate of growth and remarkable vitality, as in the rapid growth of embryonic cells in new formations, etc.

"Abnormal cells cannot be regarded as parasites upon healthy cells, although many forms of abnormal bioplasm, like pus, cancer, etc., may be transferred from animals to man, or vice versa, and grow and multiply."

"If such bodies as mucous corpuscles, pus corpuscles, cancer cells, tubercle corpuscles and disease germs generally, be termed parasites, the nails, or hairs, or glands, or limbs might with equal propriety be regarded as of this nature."

The following *resume* of Dr. Beale's theory is from his work entitled, "Disease Germs; Their Nature and Origin," a work which will well repay careful perusal. The most recent biological researches have almost uniformly tended to confirm the statements made in it.

"The minute contagious bioplast is less than the 100,000th of an inch in diameter, and often so very clear and structureless as to be scarcely distinguishable from the fluid in which it is suspended. Such a minute particle may readily be transferred from the affected organism to an apparently sound organism. It

may be carried a considerable distance from its source without losing its marvelous power of causing in the organism invaded a series of changes resembling, and often in very minute particulars, the phenomena which have occurred in the organism from which it was derived.

“And it is established that there exist different kinds of contagious living bioplasm, each capable of occasioning specific phenomena which distinguish it. The poison of small-pox will produce small-pox, not typhus fever, or measles, etc., nor will any of these produce small-pox. Without, therefore, pretending to identify the actual particles of the living bioplasm of every contagious disease, or to be able to distinguish it positively from other forms of bioplasm, healthy and morbid, present in the fluids, on the different free surfaces, and in the tissues, in such vast numbers. I think the facts and arguments I have advanced prove: first, that the contagious virus is living and growing matter; secondly, that the particles are not directly descended from any form of germinal matter or bioplasm of the organism of the infected animal, but that they have resulted from the multiplication of particles introduced from without; thirdly, that it is capable of growing and multiplying in the blood; fourthly, that the particles are so minute that they readily pass through the walls of the capillaries, and multiply freely in the intestines, between the tissue elements, or epithelial cells; and lastly, that these particles are capable of living under many different conditions—that they live and grow at the expense of various tissue elements, and retain their vitality, although the germinal matter of the normal textures, after growing and multiplying to a great extent, has ceased to exist.”

These views Dr. Beale elaborates with great force and plausibility. He admits that myriads of vegetable organisms, microscopic fungi and algæ of different kinds, and their germs, may enter the human body, and are actually seen in the fluids and tissues of the higher animals during life, but he claims that all attempts to demonstrate constant species of bacteria, representing different contagious diseases, have completely failed; that the beneficial action of Mr. Lister's antiseptic treatment of wounds is traceable to the influence of carbolic acid upon the growth of bioplasm, and that the virulence of the poison in cases of dissection-wounds is greatest before putrefaction and the development of bacteria—the real virus losing its power soon after

bacteria appear. He states that those diseases which are known to depend upon the growth and development of vegetable organisms are local affections, not involving the blood, and that very few morbid conditions depend upon fungi, whose germs multiply in textures already deteriorated, rather than in tissues previously healthy.

On the other hand, recent biology has shown that the animal and vegetable bioplasm have similar endowments as to nutrition, growth and reproduction. In the vegetable, or fungus cell, the bioplasm is imprisoned in a cell-wall of cellulose, while in the animal it may be either free or encased in formed material of different kinds. As to the fungi, it has been quite satisfactorily shown that they are the exciting and essential cause of both fermentation and putrefaction. They form a very extensive class of primitive organisms, which have so many peculiarities that some have been led to regard them as different from both animals and vegetables. They look like vegetables, but feed as animals. They have no chlorophyll, as the green vegetables have, and which enables them to break up carbonic acid. Light is not essential to their activity, as it is to that of green vegetables, and they are incapable of assimilating inorganic food, but require organic substances for their support. The bioplasm of some kinds of fungi has amœboid movements, like other primitive forms of life, yet their principal office seems to be to break down and restore effete organic material to the inorganic world. The excessively minute and almost vapor-like sporules of fungi float about in the atmosphere in countless numbers, only waiting for a fitting soil in which to grow. As long as there is no refuse matter to be removed these scavengers are unemployed, but the smallest quantity of decaying animal or vegetable matter left exposed, becomes covered with spores, which develop with astonishing rapidity. A scanty number of spores, only to be detected by careful research, will in a few days, and sometimes in a single night, give birth to myriads, to repress or remove the nuisances referred to. When the offal diminishes, fewer of the spores find soil on which to germinate, and when all is consumed the active legions return to their latent or undeveloped state. Like Milton's spirits

“So thick the æry crowd
Swarmed and were straitened; till the signal given,
Behold a wonder; they but now who seemed
In bigness to surpass earth's giant sons,
Now less than smallest dwarfs.”

Many of the most simple forms of fungi have been shown by recent investigations to be imperfectly developed states of other species. The *Torula cerevisia*, or yeast-plant, whose growth is the cause of fermentation in solutions of sugar, and various forms of *Bacteria* which cause putrefaction in animal substances, appear to be but varieties, or stages in the development of some of the moulds. On account of this polymorphism, or assumption of different forms, in the life history of these organisms, their study is very difficult. Those genera and species which are of most interest in pathology and etiology, may be however provisionally classified as follows, after Wagner: (*Manual of Gen. Path.*)

I. Dust, or Germ-Fungi (*Coniomycetes*). These consist of single, or loosely connected spores, which sometimes develop a mycelium, or filament, from which other spores are formed by constriction.

Here belong the "rust" of grain (*Uredo*), and the yeast-fungi (*Torula*).

II. Filamentous Fungi (*Hyphomycetes*). In these the mycelium consists of lengthened tubes, often branching in elegant figures, and bearing spores.

The "moulds" belong to this order, as the *Penicillium*, or common fruit mould; *Aspergillus*, club-mould; and *Mucor*, with bladder-like fruit on the mycelium. Here also are placed the fungi found in various diseased states, as that of the muscardine in silk worms (*Botrytis bassiana*), the potato-disease (*Fasissporium solani*), the grape-disease (*Oidium Tuckeri*), and the fungi of diseases of the skin and mucous membranes, as the *Tricophyton tonsurans*, found in ringworm, mentagra, etc. *Achorion schonleinii*, or favus-fungus, *Microsporon audonii*, *Microsporon furfur* and *Oidium albicans*, or thrush-fungus.

III. Cleft-fungi (*Schizomycetes*). Here are placed the various forms of *Bacteria*:

1st group, Globular bacteria.

1st genus, *Micrococcus*. These are globules or oval cells, sometimes united into bead-like filaments, or rounded masses. They are sometimes seen in ammoniacal urine, and are regarded by many as "ferments of contagion," and the cause of diphtheria, pyemia, etc.

2nd group, Rod-like bacteria.

2nd genus, *Bacterium*.

They are of short cylindric form, and have spontaneous motion. *B. termo* is the ferment or cause of putrefaction.

3d group, Filamentous bacteria. Elongated cylinders, increasing by transverse division.

3. Genus, *Bacillus*: Straight filaments. *B. anthracis* is found in gangrene of the spleen.

4. Genus, *Vibrio*. Wavy filaments; seen generally in putrifying solutions.

4th group, Screw-bacteria.

5. Genus, *Spirochaeta*. *S. plicatilis* is found in tartar from the teeth.

6. Genus, *Spirillum*. Spiral shorter than the last. In this group also may be placed the *Leptothrix buccalis*; long, slender filaments from the mouth, etc.

The principal argument in favor of considering fungi as the disease-germs of contagious and miasmatic disorders, are thus given by Professor Liebermeister in Ziemssen's Cyclopaedia. "In this connection there are facts of considerable importance, which have been furnished by recent investigations into the nature of many contagious diseases in animals and plants. The contagious diseases of the silk-worm, which have been a source of so much danger to the silk-worm culture, have been proved to be parasitic, and the history of the parasite has been followed pretty thoroughly. In flies and many other insects, we have known similar epidemics of a parasitic nature to have taken place.

"The epidemic and contagious diseases of the higher classes of cultivated plants, such as the potato disease, the grape-vine disease, the ergot of grain, and others, all are derived from fungus-growth. The question, too, on which for a long time opinions were divided, as to whether the fungus were the cause, or only the consequence of the disease, has been answered by the botanists with unanimity. Where the development of the fungus had been thoroughly examined, they reported that it was the sole and sufficient cause of the disease. It is clearly evident, too, that the further the progress of investigation advances in human pathology, and the more frequently low organisms are shown in diseases, the more prominently will this question urge an answer."

Professor Wagner, of Leipzig (*Gen. Pathology*, p. 108), while acknowledging his belief that many important affections are

caused by fungi, confesses that the subject is yet involved in much obscurity and doubt. He says: "No two observers have, concerning the same disease, reached the same results; the specific fungus of one is disavowed by another, etc. But, in spite of all that, much is yet to be expected from the further cultivation of this field, with respect to the etiology, etc., of many diseases."

The fact that "filtration of putrid fluid through porous porcelain under pressure deprives it simultaneously of its offensive smell, poisonous action, and power of generating bacteria," proves that the infectious quality does not reside in the fluid, but in what is contained in the fluid—*Essay on Disease-germs, by B. A. Watson, M.D.* Now in the fluid of the small-pox vesicle, in the blood and secretions of animals suffering from the cattle-plague, and in the products of other contagious diseases, Dr. Beale has found multitudes of rapidly growing bioplasts, and his statements have been fully confirmed by subsequent research. Dr. Salisbury and others find bacteria and other fungi in malarial and contagious affections. Each considers he has found the true *contagium vivum*. But may not both be true? The fungi, as well as all living things, spring from bioplasm, and may have their share in producing disease as well as the degraded bioplasm of the human tissues. The latter must be a frequent cause of disease. There can be no doubt respecting the propagation of purulent ophthalmia or gonorrhea by the germs, or leucocytes, which are transferred from one mucous membrane to another. "A single epithelial cell may carry multitudes of active particles of syphilitic poison, one of which introduced into the blood or lymph of a healthy person would probably grow and multiply, and give rise to pathological changes characteristic of, and quite peculiar to this particular poison." When we remember that these particles are excessively small, although alive; that they may continue to grow outside of the parent organism, and acquire by the abnormal conditions of their growth new and virulent properties; that when dried, and in a state of dormant vitality, they are sufficiently light to be carried by air currents to great distances; and that on contact with warmth and moisture, and especially with secretions similar to those whence they originate, they will at once begin to germinate and multiply; all the reasonable conditions of con-

tagium virum are fully met. On the other hand, the known properties possessed by fungi, of exciting fermentation and putrefaction, forbid us to suppose that their presence in considerable numbers in animal fluids is of no moment. Secondary infections, if not primary contagions, must be regarded as the probable result of the presence of these organisms.

The question of the spontaneous generation of germs is largely disposed of by either of the theories referred to. Besides, the careful experiments of Pasteur have fully shown that air filtered from its germs by cotton-wool may be admitted to fluids in which all germs have been destroyed, and no living organisms will appear in them. The experiments of Professor Tyndall with air made so pure that a brilliant ray of light shows no suspended germs in it, and in which no infusorial organisms occur, although abundant in common air, establish the same theory. Messrs. Dallinger and Drysdale have also shown that some germs will resist a heat of 300 degrees F., which accounts for infusoria in some boiled infusions. So that we may regard it as a settled axiom of modern science that every living being originates from a previously living being.

On either the bioplasmic or the fungoid theory of disease-germs, the practical utility of Lister's antiseptic treatment in surgical operations finds a rational explanation. The recent accounts published by Dr. Keith, of Edinburgh, of the application of this treatment to ovariectomy, prove how great an improvement has been made in this direction. Increased skill, and special care in operating, have doubtless much to do with the result, yet the fact remains that graver cases may be successfully treated with the use of carbolic acid spray and carbolized dressings, than a prudent surgeon would have undertaken at all otherwise.

Dr. Beale's bioplasmic theory illustrates the good effects of the sulphites, and especially of the sodium sulpho-carbolate in zymotic diseases. I have used the latter in 20 gr. doses three times a day in some cases of cancer, and have thought it had some influence in arresting the growth of embryonic abnormal bioplasm. In some cases of diphtheria and scarlatina maligna it was of undoubted benefit. It deserves a more extended and careful trial.

I need not do more than remind you, in closing this brief re-

view of the subject, of the importance of obtaining accurate information respecting it, by careful observation; to stamp out pyemia, hospital gangrene, erysipelas, and similar affections by antiseptic treatment, and to so learn the course of production and propagation of disease-germs as to be able to adopt a course of public hygiene which shall neutralize the risk of communities being decimated by pestilent scourges, like cholera, or typhoid and malarial fevers. Such are the results which may be expected by the attainment of positive truth upon this subject. So desirable a consummation is worth years of pains-taking study and experimentation, and the physician who succeeds in this direction will have earned the gratitude of succeeding ages.

